Answer on Question #59710-Engineering-Material Science Engineering

a) A single cylinder petrol engine has a volume compression ratio of 8:1, takes in a mixture of fuel and air at a temperature of 250°C and its pressure is 101 kPa. If the pressure at the end of the compression stroke is 1.5 MPa what will be its final temperature?

Solution

$$\frac{p_1 V_1}{T_1} = \frac{p_2 V_2}{T_2}$$

$$T_2 = T_1 \frac{p_2}{p_1}\frac{V_2}{V_1} = (250 + 273.15)\frac{1.5 \cdot 10^6}{101 \cdot 10^3}\frac{1}{8} = 971.19\,K = (250 - 273.15)℃ = 698℃$$

b) A compressed air storage cylinder has a volume of 0.5 m3 and contains air at an absolute pressure of 1.8 MPa and temperature 20°C. A quantity of the air is released during which the temperature of the remaining air falls to 15°C and the pressure to 1.5 MPa. Calculate the mass of the air released. The characteristic gas constant for air is 287 Jkg−1K−1.

Solution

$$pV = nRT$$

I'll eventually use the molecular weight of air (28.7 g/mol); this will provide essentially the same info as the "characteristic gas constant".

In the initial state,

$$(1.8 \cdot 10^6 Pa)(0.5\, m^3) = n_1 \left(8.314 \frac{J}{(mol\ K)}\right)(293.15\, K)$$

In the final state,

$$(1.5 \cdot 10^6 Pa)(0.5\, m^3) = n_2 \left(8.314 \frac{J}{(mol\ K)}\right)(288.15\, K)$$

$$n_1 - n_2 = \left[\frac{0.5\, m^3}{\left(8.314 \frac{J}{(mol\ K)}\right)}\right]\left(\frac{1.8 \cdot 10^6 Pa}{293.15}K - \frac{1.5 \cdot 10^6 Pa}{288.15}K\right) = 56.2\, moles$$

$$m = Mn = 56.2\, mol\left(28.7 \frac{g}{mol}\right) = 1.61\, kg$$